

**AXLE HOUSING COVER WITH VARIABLE THICKNESS**

**BACKGROUND OF THE INVENTION**

- [1] This application is a continuation-in-part of co-pending Serial No. 09/814,016 filed March 21, 2001.
- [2] This invention relates to an axle housing cover, and more particularly, the invention relates to an axle housing cover that is welded to an axle housing to enclose the differential.
- [3] Axle housings, particularly those used for commercial vehicles, have a rather large opening for receiving the differential, which connects opposing axle shafts. The opening is closed by an axle housing cover which is welded to the axle housing. Because the opening in the axle housing is rather large, the axle housing provides structural integrity to the axle assembly. Depending upon the size of the opening in the axle housing and other factors an axle housing cover of a particular thickness may be desirable. Due to different axle housing configurations and different size openings, it is not uncommon to manufacture three or more axle housing covers, each having a different thickness. For example, a cover may have a thickness of approximately 6 to 10 millimeters for axle housings with a rather large opening requiring increased structural integrity.
- [4] Axle housing covers include dome-shaped or concave portions that typically including a flange. The flange is welded to the axle housing about the opening. The thickness of the cover in the area of the weld provides increased structural integrity to the axle housing about the opening. Furthermore, the thickness provides a weld surface to which a weld bead may be applied to connect the cover to the axle housing. The thickness of the cover that is typically desirable in the area of the perimeter edge is usually not necessary for

the rest of the cover. Moreover, the axle housing cover typically has a uniform thickness. As a result, the cover is unnecessarily thick in the dome-shaped portion of the cover, which increases the weight and cost of the cover. Therefore, what is needed is a variable thickness cover which provides adequate thickness in the area of the weld while providing a reduced thickness in the dome-shaped portion of the cover.

### **SUMMARY OF THE INVENTION AND ADVANTAGES**

- [5] The present invention provides an axle housing cover includes a generally dome-shaped portion having a first thickness with the dome-shaped portion terminating in a perimeter edge. The perimeter edge has a second thickness greater than the first thickness with the perimeter edge providing a weld surface. Preferably, the second thickness is sufficiently thicker to provide adequate size and strength for the weld, which may be twice that of the first thickness. The second thickness provides a weld height greater than the first thickness. Since the dome-shaped portion has a reduced thickness, reinforcing ribs may be formed in the dome-shaped portion to provide increased structural integrity. The cover may include a flange extending radially from the cover, which provide the weld surface that is then welded to the axle housing. The axle housing cover may be formed by a stamping, hydroforming, or roll forming process.
- [6] Accordingly, the present provides a variable thickness cover that provides adequate thickness in the area of the perimeter edge while providing a reduced thickness in the dome-shaped portion of the cover.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

- [7] Other advantages of the present invention can be understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:
- [8] Figure 1A is a perspective view of the present invention axle and cover;
- [9] Figure 1B is a cross-sectional view of the present invention cover taken along lines 1-1 of Figure 2;
- [10] Figure 2 is a top elevational view of the present invention cover;
- [11] Figure 3 is an enlarged view of a perimeter edge of the cover shown in circle 3 of Figure 1;
- [12] Figure 4 is an enlarged view of an alternative embodiment of the perimeter edge;
- [13] Figure 5A is an enlarged view of another alternative embodiment of the perimeter edge;
- [14] Figure 5B is an another example of a weld for securing the cover perimeter shown in Figure 5A to the axle housing;
- [15] Figure 6 is a cross-sectional view of the present invention cover with a recessed boss; and
- [16] Figure 7 is a cross-sectional view of a spherical shell formed during a hydroforming process to form two present invention covers.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

- [17] An axle housing 8 having the inventive cover 10 secured to the housing 8 is shown in Figure 1A. The cover 10 encloses a ring and pinion and possibly a differential gear assembly.

The cover 10 has a perimeter 18 having a geometry according to this invention for securing the cover 10 to the housing 8 using a weld bead 24. The geometry of the perimeter 18 enables the weight of the cover 10 to be reduced by ensuring sufficient material for the weld bead 24.

[18] The axle housing cover 10 is shown in more detail in Figures 1B and 2. The cover 10 includes a dome- or concave-shaped portion 12 having a concave exterior surface 13. The dome-shaped portion 12 has a first thickness X. The dome-shaped portion 12 commonly includes an oil drain/fill hole 16. The cover 10 includes a terminal portion 17 having a circular terminal end 19 that engages the axle housing. The terminal portion 17 has a perimeter edge 18 with a second thickness Y. Preferably, the second thickness Y is greater than that of the first thickness X and in one example, is approximately twice the thickness of the first thickness X. For example, the first thickness may be in a range of 4.0 to 6 millimeters and the second thickness may be in a range of approximately 8 to 16 millimeters. The perimeter edge 18 provides a weld surface 20 to which a weld bead 24 is applied to secure the cover 10 to the axle housing 8 about the opening in the housing 8.

[19] The second thickness Y provides a weld height H that is greater than the first thickness X. The height H enables a large weld bead to be applied about the perimeter of the cover 10. Because the thickness of the dome-shaped portion 12 is reduced when compared to prior art covers, it may be desirable to form reinforcing ribs 14 into the dome-shaped portion 12 to provide increased structural integrity. By providing a cover 10 with a variable thickness, structural integrity in the area of the perimeter edge 18 may be provided while reducing the thickness in the rest of the cover 10 to reduce the weight and cost of the cover. Maintaining a suitably large thickness in the area of the perimeter edge 18 ensures that an

adequate weld bead may be used between the cover 10 and the axle housing and that the weld does not burn through the cover during the welding process. The second thickness Y prevents burn-through of the large weld in the area of the perimeter. The weld would burn-through the cover material in the area of the perimeter if it was only the thickness of first thickness X. However, that is not to say that the weld 24 cannot extend slightly beyond the height H, but rather, a substantial portion of the weld 24 is arranged between the height H and the axle housing 8. Furthermore, the second thickness Y may vary along its length, as shown in Figure 3.

[20] One embodiment of the perimeter edge 18 is shown in Figure 3. In the embodiment shown, the perimeter edge 18 does not extend beyond the concave exterior surface 13. That is, the perimeter edge is not defined by a flange. Conversely, in another embodiment shown in Figure 4, a flange 22 extends radially outwardly from the dome-shaped portion 12 to provide the perimeter edge 18. The flange 22 defines the height H in the embodiment shown. The flange may be formed by folding the terminal end 19 of the dome-shaped portion back onto itself, shown in Figures 5A and 5B. After the flange 22 has been formed a rounded portion 21 may be machined from the flange 22, best shown in Figure 5A, to provide a flat weld surface 20. A smaller weld 23 may be used to secure the folded portion to the surface 13. Alternatively, a large weld bead 24 may extend from the housing 8 to the surface 13 covering the folded portion, as shown in Figure 5B.

[21] The cover 10 may include a recessed boss 26 having an opening 28, as shown in Figure 6, formed into the cover 10 by stamping. A carrier assembly may be installed onto the boss 26 so that the carrier may be connected to the differential assembly within the axle housing.

[22] The cover 10 of the present invention may be formed using any number of suitable processes. A blank may be provided having a uniform thickness. The dome-shaped portion may then be formed to obtain a first thickness. The perimeter edge may be formed having a second thickness which is greater than the first thickness. The second thickness may be the original thickness of the blank. The cover may be formed using a stamping, hydroforming, or roll forming process. For example, a hollow blank 30 may be used having a cavity 31, as shown in Figure 7. Fluid is injected into the cavity 31 through one of the oil drain/fill holes 16. The hollow blank 30 is deformed outward and into engagement with a mold having the desired exterior shape of the cover 10. The hollow blank 30 would be formed into the spherical shell shown in Figure 7. The blank 30 may be cut along plane 34 to form a first and second covers 32a and 32b. The ribs 14 may be defined by the shape of the mold.

[23] The invention has been described in an illustrative manner, and it is to be understood that the terminology that has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.